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DESIGN AND PROTOTYPE OF MICROSTRIP POWER DIVIDER FOR ANALOG AND DIGITAL TELEVISION ANTENNA APPLICATIONS AT THE FREQUENCY OF 479-799 MHz

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ABSTRACT

This research discuss about design and prototype of Wilkinson power divider with a microstrip transmission line. Power divider that is designed has one input port and two or more output ports with the input and output line characteristic impedance of 75Ω. Power divider is designed to be applied to the analog and digital terrestrial television antenna receiver in Indonesia at a frequency of 479 - 799 MHz using FR4 substrate material (dielectric constant εr = 4.3) and a copper conductor material. Design and simulation of power divider is done using the CST Microwave Studio. The simulation results of power divider in the frequency range 479 - 799 MHz shows the value of S11, S22, and S33 ≤ -15 dB, S21 value between -3,054 - -3,136 dB, the value S31 between -3.052 - -3.137 dB, and the value of S23 and S32 ≤ -15 dB. Results of measurement of power divider in the frequency range 479 - 799 MHz shows that the minimum S11 value is -14.38 dB. The minimum S22 value is -14.97 dB. The minimum S33 value is -15.17 dB. The minimum S21 value is -3.68 dB and the maximum is -4.35 dB. The minimum S31 value is -3.51 dB and the maximum is -4.37 dB. The minimum S23 value is -17.12 dB.

Keyword: wilkinson power divider, microstrip, television antenna.

INTRODUCTION

Television is one of the media information that is widely used, especially by the people of Indonesia. As many as 95% of Indonesian people still choose to use television as a medium for information. Looking from the number of television users in Indonesia, it can not be denied that in one house or one place there are more than one television set in which each television sets will be connected to an antenna. To save the cost of purchasing an antenna and to save space for laying the antenna, we can use the power divider that serves to divide the output power of the antenna to multiple ports so that the antennas can be used for a number of television sets at once [1-3].

DESIGN AND RESULT

Design concept

Power divider is a passive microwave component that is used to divide the signal power from one input port into two or more output ports [4-8]. In general, the power divider can also be used as a power combiner that combines multiple signals from one input port to the output port. Power divider can be designed to have the same power division (equal) or not (unequal).

Wilkinson power divider is found by E.J. Wilkinson. An early form of power divider / combiner of this type have three ports and has a function to divide power equally from one port to two output ports as well as to combine two input signals into one output signal. Wilkinson power divider can be designed to split the input power with different ratios according to the necessity of its output port [9-12].

At Wilkinson power divider, a resistor is used to connect two output ports that serve to increase the isolation between ports. This resistor is often called the "resistor of isolation" and placed as far as a quarter wavelengths (λ/4) of the tip of branching. The value of the isolation resistor is $2Z_0$. Two branching line of Wilkinson power divider has a characteristic impedance of $\sqrt{2}\,Z_0$. Bandwidth of Wilkinson power divider can be improved by using multiple sections (multi-section) that arranged cascade [13].

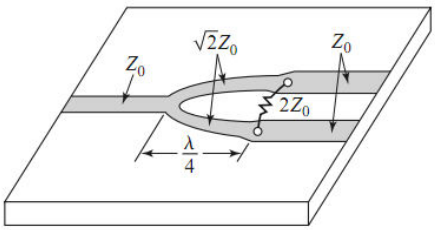

Figure 1. 2-Way wilkinson power divider [1].

The power divider is designed to work at frequencies of 479-799 MHz and Z_0 = 75Ω. The power divider has microstrip line type with 1.6 mm thick Epoxy material (dielectric constant (ε_r) = 4.3). Figure-2 shows the design of the power divider. The dimensions of power divider are given in Table-1.

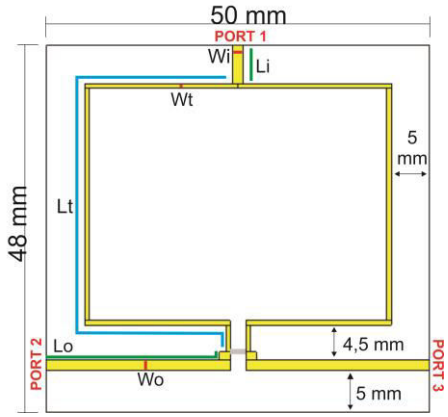

Figure 2. Power divider design.

Table-1. Dimensions of power divider.

Dimension Symbol	Dimension Name	Size (mm)
Wi	Input Line Width	1.45
Wt	Transformer Line Width	0.6
Wo	Output Line Width	1.45
Li	Input Line Length	5
Lt	Transformer Line Length	73.5
Lo	Output Line Length	23.55

RESULT

Return loss

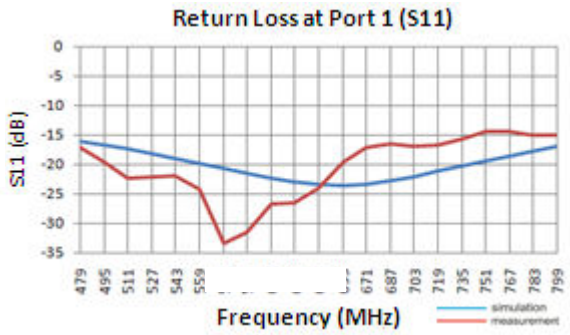

Figure 3. Return loss Port 1 (S11).

Based on simulation results, minimum value of -16.19 dB and the maximum value of -23.54 dB for S11 is obtained. However, based on the measurement results, S11 have minimum value of -14.38 dB and the maximum value of -33.48 dB.

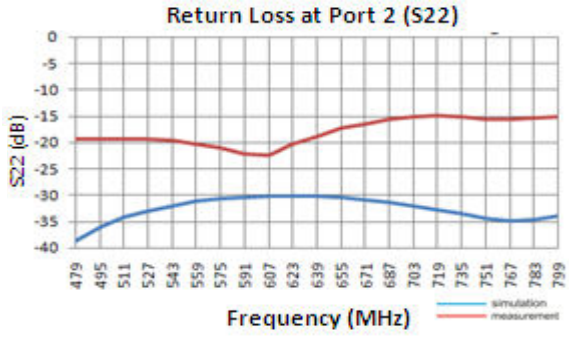

Figure-4. Return loss Port 2 (S22).

Based on simulation results, minimum value of -30.15 dB and the maximum value of -38.56 dB for S22 is obtained. However, based on the measurement results, S22 have minimum value of -14.97 dB and the maximum of -22.37 dB.

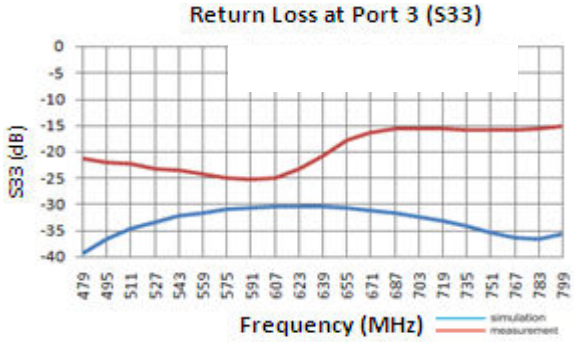

Figure-5. Return loss Port 3 (S33).

Based on simulation results, minimum value of -30.51 dB and the maximum value of -39.44 dB for S33 is obtained. However, based on the measurement results, S33 have minimum value of -15.17 dB and the maximum value of -25.37 dB.

Insertion loss

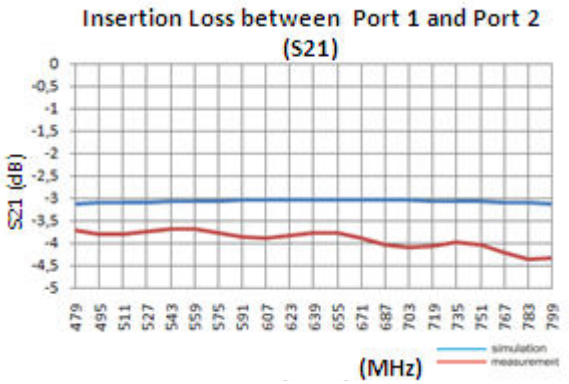

Figure 6. Insertion loss between Port 1 and Port 2.

Based on simulation results, S21 obtained minimum value of -3.054 dB and the maximum value of -3.136 dB. However, based on the measurement results, S21 obtained minimum value of -3.68 dB and the maximum value of -4.35 dB.

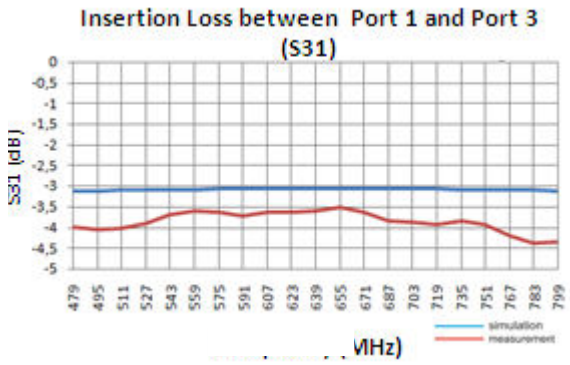

Figure 7. Insertion loss between Port 1 and Port 3.

Based on simulation results, S31 obtained minimum value of -3.052 dB and the maximum value of -3.137 dB. However, based on the measurement results, S31 obtained minimum value of -3.51 dB and the maximum value of -4.37 dB.

Isolation

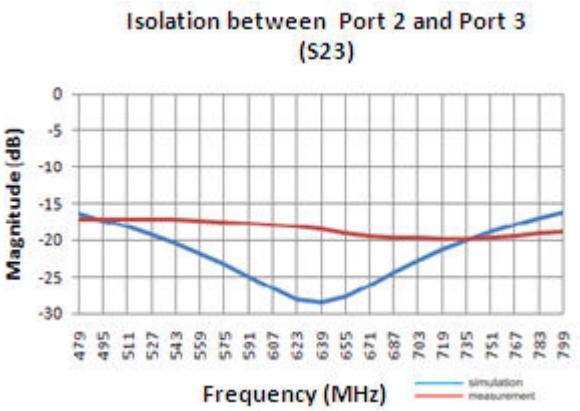

Figure-8. Isolation between Port 2 and Port 3.

Based on simulation results, S23 obtained minimum value of -16.16 dB and the maximum value of -28.56 dB. However, based on the measurement results, S23 obtained minimum value of -17.12 dB and the maximum value of -19.92 dB.

CONCLUSIONS

Based on the simulation results of power divider at the frequency of 479-799 MHz, the following parameters are obtained:

S11 min = -16.19 dB, S11 max = -23.54 dB. S22 min = -30.15 dB, S22 max = -38.56 dB. S33 min = -30.51 dB, S33 max = -39.44 dB. S21 min = -3.054 dB, S21 max = -3.136 dB. S31 min = -3.052 dB, S31 max = -3.137 dB. S23 min = -16.16 dB, S23 max = -19.92 dB.

However, based on the measurement results of power divider at the frequency of 479-799 MHz, the following parameters are obtained:

S11 min = -14.38 dB, S11 max = -33.48 dB. S22 min = -14.97 dB, S22 max = -22.37 dB. S33 min = -15.17 dB, S33 max = -25.37 dB. S21 min = -3.68 dB, S21 max = -4.35 dB. S31 min = -3.51 dB, S31 max = -4.37 dB. S23 min = -17.12 dB, S23 max = -19.92 dB.

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